PATENT COOPERATION TREATY

From the INTERNATIONAL BUREAU

PCT

NOTIFICATION OF ELECTION

(PCT Rule 61.2)

To:

United States Patent and Trademark Office
(Box PCT)
Crystal Plaza 2
Washington, DC 20231
ÉTATS-UNIS D'AMÉRIQUE

in its capacity as elected Office

Date of mailing (day/month/year) 07 January 1999 (07.01.99)	
International application No. PCT/DK98/00154	**Applicant's or agent's file reference** P 1997 00605 WO
International filing date (day/month/year) 14 April 1998 (14.04.98)	**Priority date** (day/month/year) 14 April 1997 (14.04.97)
Applicant HENNINGSEN, Henning	

1. The designated Office is hereby notified of its election made:

   [X] in the demand filed with the International Preliminary Examining Authority on:

   05 November 1998 (05.11.98)

   [ ] in a notice effecting later election filed with the International Bureau on:

2. The election [X] was

   [ ] was not

   made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

The International Bureau of WIPO **34, chemin des Colombettes** **1211 Geneva 20, Switzerland**	Authorized officer P. Regis
Facsimile No.: (41-22) 740.14.35	Telephone No.: (41-22) 338.83.38

Copy for the Elected Office (EO 5)

PCT/DK98/00154

PATENT COOPERATION TREATY

From the INTERNATIONAL BUREAU

PCT

NOTIFICATION OF THE RECORDING OF A CHANGE

(PCT Rule 92bis.1 and Administrative Instructions, Section 422)

To:

PATENTGRUPPEN APS
Arosgaarden
Aaboulevarden 31
DK-8000 Aarhus C
DANEMARK

Date of mailing (day/month/year)
17 August 1999 (17.08.99)

Applicant's or agent's file reference
P 1997 00605 WO

IMPORTANT NOTIFICATION

International application No.
PCT/DK98/00154

International filing date (day/month/year)
14 April 1998 (14.04.98)

1. The following indications appeared on record concerning:

[ ] the applicant [ ] the inventor [X] the agent [ ] the common representative

Name and Address

HOFMAN-BANG & BOUTARD, LEHMANN &
REE A/S
Ryesgade 3
P.O. Boks 367
DK-8100 Århus C
Denmark

State of Nationality:

State of Residence:

Telephone No.
45 86 20 22 22

Facsimile No.
45 86 20 22 10

Teleprinter No.:

2. The International Bureau hereby notifies the applicant that the following change has been recorded concerning:

[X] the person [X] the name [X] the address [ ] the nationality [ ] the residence

Name and Address

PATENTGRUPPEN APS
Arosgaarden
Aaboulevarden 31
DK-8000 Aarhus C
Denmark

State of Nationality:

State of Residence:

Telephone No.
45 86 19 20 00

Facsimile No.
45 86 19 91 91

Teleprinter No.:

3. Further observations, if necessary:

4. A copy of this notification has been sent to:

[X] the receiving Office
[ ] the International Searching Authority
[ ] the International Preliminary Examining Authority
[ ] the designated Offices concerned
[X] the elected Offices concerned
[ ] other:

The International Bureau of WIPO
34, chemin des Colombettes
1211 Geneva 20, Switzerland

Facsimile No.: (41-22) 740.14.35

Authorized officer

Dominique DELMAS

Telephone No.: (41-22) 338.83.38

Form PCT/IB/306 (March 1994)

002793206

PATENT COOPERATION TREATY

From the
INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

REC'D 15 DEC 1998

PCT

To:

The International Bureau of WIPO
34, chemin des Colombettes
CH - 1211 Geneva 20
Switzerland

NOTIFICATION CONCERNING
DOCUMENTS TRANSMITTED

Date of mailing
(day/month/year) 10. 12. 98

International application No: PCT/DK98/00154

This International Preliminary Examining Authority transmits herewith the following documents:

1. ☐ demand (Rule 61.1(a)).

2. ☒ copy of the international preliminary examination report and its annexes (Rule 71.1).

3. ☐ _____ other documents *(specify)*:

Name und mailing address of the IPEA/

European Patent Office
D-80298 Munich
Tel. (+49-89) 2399-0, Tx: 523656 epmu d
Fax: (+49-89) 2399-4465

Authorized officer

Voigt, C

Tel. (+49-89) 2399-2238

Form PCT/IPEA/415 (January 1995)

PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference	FOR FURTHER ACTION	See Notification of Transmittal of International Preliminary Examination Report (PCT/IPEA/416)
P 1997 00605 WO		
International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/DK98/00154	14/04/1998	14/04/1997
International Patent Classification (IPC) or national classification and IPC		
G02F1/1335		
Applicant		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 6 sheets, including this cover sheet.

   ☐ This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consist of a total of sheets.

3. This report contains indications relating to the following items:

I	☒	Basis of the report
II	☐	Priority
III	☐	Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
IV	☐	Lack of unity of invention
V	☒	Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
VI	☐	Certain documents cited
VII	☐	Certain defects in the international application
VIII	☒	Certain observations on the international application

Date of submission of the demand	Date of completion of this report
05/11/1998	10. 12. 98
Name and mailing address of the IPEA/	Authorized officer
European Patent Office D-80298 Munich Tel. (+49-89) 2399-0, Tx: 523656 epmu d Fax: (+49-89) 2399-4465	Lerbinger, K Telephone No. (+49-89) 2399-2274

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/DK98/00154

I. Basis of the report

1. This report has been drawn on the basis of (*substitute sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to the report since they do not contain amendments.*):

Description, pages:

1-16 as originally filed

Claims, No.:

1-22 as originally filed

Drawings, sheets:

1/3-3/3 as originally filed

2. The amendments have resulted in the cancellation of:

☐ the description, pages:
☐ the claims, Nos.:
☐ the drawings, sheets:

3. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

4. Additional observations, if necessary:

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	1-22
	No:	Claims	
Inventive step (IS)	Yes:	Claims	1-22
	No:	Claims	
Industrial applicability (IA)	Yes:	Claims	1-22
	No:	Claims	

2. Citations and explanations

see separate sheet

VIII. Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:

see separate sheet

Concerning section V

1 The independent claims 1 and 12 are considered to be unclear, for reasons explained in section VIII, so that the claims do not meet the requirements of Article 6 PCT. Subject to this objection, the subject-matter of the claims is new and inventive.

2 The following three documents are cited in the international search report as being of particular relevance.

2.1 US-A-5,444,235 describes an apparatus (see figure 1) comprising
(i) 10 light valves, each light valve having a 256x256 array of pixels,
(ii) 10 fibre cables, each cable including 65,536 optical fibres,
(iii) a sensor including a 256x256 array of sensor elements,
wherein each optical fibre of each cable connects one pixel to one sensor element, so that each sensor element is connected to 10 pixels.

2.2 US-A-4,859,034 describes an apparatus (see figure 13) comprising
(i) a light source,
(ii) a light concentrating device,
(iii) a liquid crystal panel comprising a plurality of light valves,
(iv) a self-focusing lens array,
(v) a photosensitive drum.
The light concentrating device is a plate like light guide.

2.3 US-A-5,394,254 describes an apparatus comprising
(i) a cathode ray tube,
(ii) a fibre optic plate arrangement,
(iii) a liquid crystal cell including a photoconductive layer.

2.4 Since none of the available prior art documents discloses an illumination unit comprising two light guides and a plurality of light valves wherein each of the light guides is arranged to illuminate a plurality of light valves, the subject-matter of claim is novel.

3 The illumination unit as is known from US-A-4,899,222 requires one optical fibre for each illumination point. This leads to a large number of optical fibres. Consequently, the device is complex and requires very precise adjustment of the fibres. The present application suggest to use lightguides which illuminates a plurality of light valves. The available prior art documents contain no suggestion of this development. Consequently, the subject-matter of the independent claims is based on an inventive step.

4 Dependent claims 2 to 19, 21 and 22 defines modifications of subject-matter which is novel and is based on an inventive step.

5 The requirements of industrial applicability are fulfilled.

Concerning section VIII

1 Claim 1 is considered to be unclear for the following reasons:-

From page 11, lines 12 to 15 of the description it is clear that for the illumination unit to function this unit must comprise a lamp which is optically connected with a plurality of light receiving ends of light guides. This is not defined in the claim, thus indicating that the claim is lacking a technical feature which is essential to the invention.

2 Independent method claim 20 is directed to a method of point illumination of a medium. Hence one would expect at least one step of a method. Contrary to this expectation the claim merely recites the features of illumination unit as specified in claim 1.

3 The dependency of claim 13 is incorrect. This claims refers back to claims 1 to 12. However, it is only in claim 12 that the illumination heads are mentioned for the first time. Thus claim 13 which further defines these illumination heads can only refer back to claim 12.

4 The dependency of claims 16 and 17 is incorrect. These claims refer back to claim 15 which defines that the light valves are formed by electrooptically based light valves. However, claim 16 defines that the light valves are formed by reflection based electromechanical light valves and claim 17 defines that the light valves are formed by transmission based electromechanical light valves.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/DK 98/00154

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: G02F 1/1335, H04N 9/31
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: G02F, H04N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPI

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5444235 A (G.R. REDFORD), 22 August 1995 (22.08.95), column 3, line 35 - column 4, line 27, figure 1, abstract --	1,4-20
X	US 4859034 A (Y. SHIRAISHI ET AL.), 22 August 1989 (22.08.89), column 4, line 46 - line 56; column 16, line 64 - column 17, line 34, figures 8,13, abstract --	1,4-20
X	US 5394254 A (L.T. CHENG), 28 February 1995 (28.02.95), column 5, line 51 - column 6, line 45, figure 6, abstract --	1,4-20

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" erlier document but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
21 August 1998	26 -08- 1998
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Karin Säfsten Telephone No. +46 8 782 25 00

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT
Information on patent family members

27/07/98

International application No.
PCT/DK 98/00154

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5444235 A	22/08/95	AU 672140 B	19/09/96
		AU 7888194 A	15/06/95
		EP 0656724 A	07/06/95
		JP 7255006 A	03/10/95
US 4859034 A	22/08/89	EP 0083253 A	06/07/83
		JP 58114978 A	08/07/83
		US 4589732 A	20/05/86
US 5394254 A	28/02/95	NONE	
US 5583669 A	10/12/96	JP 6034963 A	10/02/94
		US 5689315 A	18/11/97
		JP 6118369 A	28/04/94
		JP 6118370 A	28/04/94

PCT

REQUEST

The undersigned requests that the present international application be processed according to the Patent Cooperation Treaty.

For receiving Office use only

International Application No. PCT/DK98/00154

International Filing Date 14 APRIL 1998

Patentdirektoratet
Danish Patent Office

Name of receiving Office and "PCT International Application" PCT-International Application

Applicant's or agent's file reference *(if desired) (12 characters maximum)* P 1997 00605 WO

Box No. I TITLE OF INVENTION

An apparatus and a method for illuminating a light-sensitive medium

Box No. II APPLICANT

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (i.e. country) of residence if no State of residence is indicated below.)*

Dicon A/S
Sønderskovvej 5
8520 Lystrup
Denmark

☐ This person is also inventor.

Telephone No.

Facsimile No.

Teleprinter No.

State *(i.e. country)* of nationality: DK Denmark

State *(i.e. country)* of residence: DK Denmark

This person is applicant for the purposes of: ☐ all designated States ☒ all designated States except the United States of America ☐ the United States of America only ☐ the States indicated in the Supplemental Box

Box No. III FURTHER APPLICANT(S) AND/OR (FURTHER) INVENTOR(S)

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (i.e. country) of residence if no State of residence is indicated below.)*

HENNINGSEN, Henning
Nørregade 25
8670 Låsby
Denmark

This person is:

☐ applicant only

☒ applicant and inventor

☐ inventor only *(If this check-box is marked, do not fill in below.)*

State *(i.e. country)* of nationality: DK Denmark

State *(i.e. country)* of residence: DK Denmark

This person is applicant for the purposes of: ☐ all designated States ☐ all designated States except the United States of America ☒ the United States of America only ☐ the States indicated in the Supplemental Box

☐ Further applicants and/or (further) inventors are indicated on a continuation sheet.

Box No. IV AGENT OR COMMON REPRESENTATIVE; OR ADDRESS FOR CORRESPONDENCE

The person identified below is hereby/has been appointed to act on behalf of the applicant(s) before the competent International Authorities as: ☒ agent ☐ common representative

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)*

Hofman-Bang & Boutard, Lehmann & Ree A/S
Ryesgade 3
P.O.Boks 367
8100 Århus C.
Denmark

Telephone No. +45 86 20 22 22

Facsimile No. +45 86 20 22 10

Teleprinter No.

☐ Mark this check-box where no agent or common representative is/has been appointed and the space above is used instead to indicate a special address to which correspondence should be sent.

CONFIRMATION COPY

Box No.V DESIGNATION OF STATES

The following designations are hereby made under Rule 4.9(a) *(mark the applicable check-boxes; at least one must be marked)*:

Regional Patent

- ☒ AP **ARIPO Patent:** **GH** Ghana, **GM** Gambia, **KE** Kenya, **LS** Lesotho, **MW** Malawi, **SD** Sudan, **SZ** Swaziland, **UG** Uganda, **ZW** Zimbabwe, and any other State which is a Contracting State of the Harare Protocol and of the PCT
- ☒ EA **Eurasian Patent:** **AM** Armenia, **AZ** Azerbaijan, **BY** Belarus, **KG** Kyrgyzstan, **KZ** Kazakhstan, **MD** Republic of Moldova, **RU** Russian Federation, **TJ** Tajikistan, **TM** Turkmenistan, and any other State which is a Contracting State of the Eurasian Patent Convention and of the PCT
- ☒ EP **European Patent:** **AT** Austria, **BE** Belgium, **CH and LI** Switzerland and Liechtenstein, **DE** Germany, **DK** Denmark, **ES** Spain, **FI** Finland, **FR** France, **GB** United Kingdom, **GR** Greece, **IE** Ireland, **IT** Italy, **LU** Luxembourg, **MC** Monaco, **NL** Netherlands, **PT** Portugal, **SE** Sweden, and any other State which is a Contracting State of the European Patent Convention and of the PCT * CY Cyprus
- ☒ OA **OAPI Patent:** **BF** Burkina Faso, **BJ** Benin, **CF** Central African Republic, **CG** Congo, **CI** Côte d'Ivoire, **CM** Cameroon, **GA** Gabon, **GN** Guinea, **ML** Mali, **MR** Mauritania, **NE** Niger, **SN** Senegal, **TD** Chad, **TG** Togo, and any other State which is a member State of OAPI and a Contracting State of the PCT *(if other kind of protection or treatment desired, specify on dotted line)* .....

National Patent *(if other kind of protection or treatment desired, specify on dotted line)*:

- ☒ AL Albania
- ☒ AM Armenia
- ☒ AT Austria and utility model
- ☒ AU Australia
- ☒ AZ Azerbaijan
- ☒ BA Bosnia and Herzegovina
- ☒ BB Barbados
- ☒ BG Bulgaria
- ☒ BR Brazil
- ☒ BY Belarus
- ☒ CA Canada
- ☒ CH and LI Switzerland and Liechtenstein
- ☒ CN China
- ☒ CU Cuba
- ☒ CZ Czech Republic and utility model
- ☒ DE Germany and utility model
- ☒ DK Denmark and utility model
- ☒ EE Estonia and utility model
- ☒ ES Spain
- ☒ FI Finland and utility model
- ☒ GB United Kingdom
- ☒ GE Georgia
- ☒ GH Ghana
- ☒ GM Gambia
- ☒ GW Guinea-Bissau
- ☒ HU Hungary
- ☒ ID Indonesia
- ☒ IL Israel
- ☒ IS Iceland
- ☒ JP Japan
- ☒ KE Kenya
- ☒ KG Kyrgyzstan
- ☒ KP Democratic People's Republic of Korea
- ☒ KR Republic of Korea
- ☒ KZ Kazakhstan
- ☒ LC Saint Lucia
- ☒ LK Sri Lanka
- ☒ LR Liberia
- ☒ LS Lesotho
- ☒ LT Lithuania
- ☒ LU Luxembourg
- ☒ LV Latvia
- ☒ MD Republic of Moldova
- ☒ MG Madagascar
- ☒ MK The former Yugoslav Republic of Macedonia
- ☒ MN Mongolia
- ☒ MW Malawi
- ☒ MX Mexico
- ☒ NO Norway
- ☒ NZ New Zealand
- ☒ PL Poland
- ☒ PT Portugal
- ☒ RO Romania
- ☒ RU Russian Federation
- ☒ SD Sudan
- ☒ SE Sweden
- ☒ SG Singapore
- ☒ SI Slovenia
- ☒ SK Slovakia and utility model
- ☒ SL Sierra Leone
- ☒ TJ Tajikistan
- ☒ TM Turkmenistan
- ☒ TR Turkey
- ☒ TT Trinidad and Tobago
- ☒ UA Ukraine
- ☒ UG Uganda
- ☒ US United States of America
- ☒ UZ Uzbekistan
- ☒ VN Viet Nam
- ☒ YU Yugoslavia
- ☒ ZW Zimbabwe

Check-boxes reserved for designating States (for the purposes of a national patent) which have become party to the PCT after issuance of this sheet:

- ☒ ~~CY Cyprus~~ (European Patent)
- ☐
- ☐

In addition to the designations made above, the applicant also makes under Rule 4.9(b) all designations which would be permitted under the PCT except the designation(s) of _____.

The applicant declares that those additional designations are subject to confirmation and that any designation which is not confirmed before the expiration of 15 months from the priority date is to be regarded as withdrawn by the applicant at the expiration of that time limit. *(Confirmation of a designation consists of the filing of a notice specifying that designation and the payment of the designation and confirmation fees. Confirmation must reach the receiving Office within the 15-month time limit.)*

Box No. VI PRIORITY CLAIM Further priority claims are indicated in the Supplemental Box ☐

The priority of the following earlier application(s) is hereby claimed:

Country (in which, or for which, the application was filed)	Filing Date (day/month/year)	Application No.	Office of filing (only for regional or international application)
item (1) DK Denmark	14.04.1997 14 April 1997	415/97	
item (2) DK Denmark	16.01.1998 16 January 1998	63/98	
item (3)			

Mark the following check-box if the certified copy of the earlier application is to be issued by the Office which for the purposes of the present international application is the receiving Office (a fee may be required):

☒ The receiving Office is hereby requested to prepare and transmit to the International Bureau a certified copy of the earlier application(s) identified above as item(s) : (1), (2)

Box No. VII INTERNATIONAL SEARCHING AUTHORITY

Choice of International Searching Authority (ISA) *(If two or more International Searching Authorities are competent to carry out the international search, indicate the Authority chosen; the two-letter code may be used):* ISA / SE

Earlier search *Fill in where a search (international, international-type or other) by the International Searching Authority has already been carried out or requested and the Authority is now requested to base the international search, to the extent possible, on the results of that earlier search. Identify such search or request either by reference to the relevant application (or the translation thereof) or by reference to the search request:*

Country (or regional Office): Date *(day/month/year)*: Number:

Box No. VIII CHECK LIST

This international application contains the following number of sheets:

1. request	: 3	sheets
2. description	: 17	sheets
3. claims	: 5	sheets
4. abstract	: 1	sheets
5. drawings	: 3	sheets
Total	: 29	sheets

This international application is accompanied by the item(s) marked below:

1. ☐ separate signed power of attorney
2. ☐ copy of general power of attorney
3. ☐ statement explaining lack of signature
4. ☐ priority document(s) *identified in Box No. VI as item(s):*
5. ☒ fee calculation sheet
6. ☐ separate indications concerning deposited microorganisms
7. ☐ nucleotide and/or amino acid sequence listing (diskette)
8. ☐ other *(specify)*:

Figure No. 1 of the drawings (if any) should accompany the abstract when it is published.

Box No. IX SIGNATURE OF APPLICANT OR AGENT

Next to each signature, indicate the name of the person signing and the capacity in which the person signs (if such capacity is not obvious from reading the request).

Claus Elmeros
Hofman-Bang & Boutard, Lehmann & Ree A/S

For receiving Office use only

1. Date of actual receipt of the purported international application: RO/DK 14 APR 1998 (14.04.98)
2. Drawings: ☐ received: ☐ not received:
3. Corrected date of actual receipt due to later but timely received papers or drawings completing the purported international application:
4. Date of timely receipt of the required corrections under PCT Article 11(2):
5. International Searching Authority specified by the applicant: ISA / SE
6. ☐ Transmittal of search copy delayed until search fee is paid

For International Bureau use only

Date of receipt of the record copy by the International Bureau: 04 MAY 1998 (04.05.98)

See Notes to the request form

APPARAT OG FREMGANGSMÅDE TIL BELYSNING AF ET LYSFØLSOMT MEDIUM.

Teknikkens baggrund

Opfindelsen angår en belysningsenhed samt en fremgangsmåde til punktvis belysning af et medium omfattende en flerhed af lysgivere i form af lysledere, der via et lysventilarrangement er arrangeret til belysning af mindst én belysningsflade, idet lysventilarrangementet omfatter et antal elektrisk styrede light valves.

Der kendes forskellige typer af belysningssystemer af den type hvor en kontinuerlig højeffektlyskilde, eksempelvis Hg- eller Xe- lampe, belyser et antal belysningspunkter på et lysfølsomt medium via en given type lysmodulatorer.

Teknologien er imidlertid ikke slået helt igennem kommercielt, da mange lysventiltyper har meget lav udnyttelsesgrad, hvorfor en fordeling af lys over en større belysningsflade typisk vil give større optiske tab og dermed medføre at den afgivne optiske effekt på belysningsstedet bliver reduceret væsentligt. Som et resultat af dette forhold vil der oftest være en tendens til, at den til rådighed værende optiske energi koncentreres i ét bestemt mindre belysningsområde, fremfor at forsøge at fordele denne over et større område i længere tid på grund af den begrænsede belysningseffekt og derved opnå en reduceret belysningseffekt over de enkelte belysningspunkter.

En ulempe ved den kendte teknik afledt af ovennævnte problemstilling er, at det er nødvendigt at placere et meget stort antal lysventiler i et lysventilarray på et meget lille areal, da det er meget vanskeligt at distribuere tilstrækkelig optisk effekt ud over en større

areal, ligesom det er vanskeligt at opnå en uniform fladebelysning.

I forbindelse med computer to plate teknologi, der eksempelvis kendes fra US patent nr. 5,049,901, hvor der foretages en belysning på eksempelvis trykplader via DMD lysventiler opstår der således det problem, at det ikke er muligt at opnå tilstrækkelig optisk effekt distribueret over et større areal. Patentet beskriver således, hvorledes en belysning på en scannelinie fastholdes bedst muligt i den længst mulige tid ved at belyse samme scannelinie med flere rækker af lysventiler. En anden konsekvens af den relativt lave belysningsefffekt kan også være, at der må anvendes specialtrykplader med en forøget lysfølsomhed, der for det første er dyre i brug, og for det andet stiller større krav til opbevaring og anvendelse end de konventionelle trykplader. En yderligere mulig konsekvens af denne relativt lave opnåelige optiske energi er at systemets belysningstid må forøges væsentligt. Denne forøgelse af tidsforbrug er imidlertid ikke særlig hensigtsmæssig, da den samlede nødvendige eksponeringstid for en trykplade bliver forøget væsentligt.

En yderligere ulempe ved en optisk distribution over et større areal er, at anvendelse af eksempelvis et større antal af lyskilder kan give anledning til ret markante randproblemer, der forekommer ved grænseområderne mellem de enkelte lyskilders belysningsprofiler og belysningsareal. Disse randproblemer har hidtil været undgået ved enten at belyse et belysningsområde med den samme lysgiver, eller alternativt at belyse hvert enkelt belysningspunkt med et separat optisk fiber. Systemer af den førstnævnte type, der kendes fra US patentskrift nr. 4,675,702, har den ulempe, at belysningsområdet begrænses fysisk, hvorved en kompliceret relativ mekanisk bevægelse

mellem belysningsenheden og underlaget vil være nødvendig.

Den sidstnævnte type tilvejebringer en uniform belysning på belysningsfladen, idet belysningsintensiteten varierer mellem hvert belysningspunkt, således at variansen i belysningsintensiteten ikke bliver synlig. En ulempe ved den sidstnævnte type, der kendes fra US patentskrift nr. 4,899,222, er at systemet bliver overordentligt kompliceret, idet der kræves et optisk fiber for hvert belysningspunkt. Dette medfører dels, at lysdistributionen fra lyskilden til lysmodulatorerne kræver anvendelse af et meget stort antal optiske fibre, og dels at der stilles krav om en meget præcis justering af hvert enkelt optisk fiber i forhold til såvel lyskilde som lysmodulatorerne. Det skal i den forbindelse erindres, at hvert eneste optiske fiber skal genjusteres ved rutinemæssig udskiftning af lyskilde.

De ovennævnte lysmodulatorsystemer er yderligere behæftet med den ulempe at transmissionsdæmpningen er meget høj, hvorved højeffektbelysning på det medium, der skal belyses, bliver særdeles vanskelig eller decideret umulig.

Opfindelsens baggrund

Ved, som angivet i krav 1 at arrangere mindst to af lysgiverne til hver at belyse en flerhed af lysventiler, opnås mulighed for en meget høj transmitteret belysningsintensitet kombineret med en meget ensartet og uniform fladebelysning.

I den kendte teknik forekommer der således ikke en decideret effektiv målrettet distribution fra mere end én lysgiver over et større areal eller delareal af lysventiler. Ved at foretage en distribution af lys via

flere lysledere, der hver belyser et antal lysventiler, opnås ligeledes mulighed for på enkel vis at anvende flere lyskilder, idet hver lyskilde således kan dedikeres til netop én lysleder, således at den opnåede effekt bliver maksimal.

En yderligere fordel ved at distribuere lys ved hjælp af lysledere er, at lys på passende måde kan blandes i koblere eller lignende til opnåelse af en større opsummeret transmitteret effekt i de enkelte lysledere.

En yderligere fordel ved opfindelsen er, at det gradvist bliver muligt at opnå forøgede indgangseffekter fra eksempelvis lamper i UV-området, således at den til lysventilerne transmitterede effekt bliver så stor, at de enkelte lysledere kan afgive lys, der har tilstrækkelig stor energi til af belyse flere lysventiler på én gang.

I forbindelse med anvendelse af eksempelvis UV-lamper, har det ligeledes vist sig, at introduktionen af "makrobelysningsområder", dvs. hvert område, der belyses af en enkelt lysleder, ikke giver væsentlige randeffekter mellem hvert belysningsområde, ligesom det har vist sig, at eventuelle større variationer mellem de afgivne effekter fra hver lysleder (som funktion af en varierende intensitetsprofil fra en tilkoblet lampe for eksempel på grund af forskellig placering af indkoblingsoptikken til de enkelte fibre i forhold til lampen), kan udkompenseres ved en passende mixning af lyslederne, hvorved resultatet af den færdige belysning er en ensartet visuel fremtoning, uden væsentlige markante intensitetsforskelle i randområderne.

Den ovenfor omtalte mixning kan eksempelvis udføres under hensyntagen til, at nabo-makrobelysningsområder får tilført optisk effekt, der ikke afviger væsentligt

indbyrdes, mens makrobelysningsområder, der er orienteret relativt fjernt indbyrdes, kan have en noget større intensitetsforskel, uden at dette giver væsentlige visuelle forstyrrelser på belysningsfladen.

En yderligere fordel ifølge opfindelsen kan opnås ved at filtrere lyset til eller afgivet fra de enkelte lysledere, således at belysningsintensiten er ensartet for alle eller en del af lyslederne.

Et apparat ifølge opfindelse kan til forskel fra den kendte teknik således opbygges på en relativ simpel måde under samtidig opnåelse af en høj opløsning, høj belysningshastighed, god præcision og uniform belysningsintensitet over et meget stort belysningsareal.

Opfindelsen er særlig fordelagtig i forbindelse med lysventiler, der er behæftet med relativt store tab. Et eksempel på sådanne lysventiltyper kan eksempelvis være elektrooptisk baserede lysventiler, såsom LCD, PDLC, PLZT, FELCD og Kerr-cells. Andre typer lysventiler kan eksempelvis være elektromekaniske reflektionsbaserede lysmodulatorer af DMD-typen.

Ifølge opfindelsen er det således muligt på enkel vis at opsummere lys over en stor flade under anvendelse af relativt få lysledere, ligesom det bliver muligt at orientere lysgiverne i belysningssystemet relativt frit, da lysgiverne består af lyslederender fremfor eksempelvis en lyskilde med tilhørende optisk system, drivere og kølemidler.

En særlig fordelagtig udførelsesform ifølge opfindelsen opnås for transmissive lysventiler, da disse resulterer i færrest mulige optiske tab, hvilket kan være helt afgørende for visse applikationers funktionalitet.

Ved, som angivet i krav 2, yderligere at lade belysningsenheden omfatte et første linsearrangement, idet linsearrangementet omfatter mindst én microlinse arrangeret i forhold til hver lysventil, således at det af lysgiveren eller lysgiverne afgivne lys fokuseres på eller i omegnen af den optiske akse for de enkelte lysventiler, opnås høj udnyttelse af den fra lysgiveren afgivne lyseffekt.

Ved, som angivet i krav 3, at lade belysningsarrangementet yderligere omfatte et andet microlinsearrangement arrangeret mellem lysventilerne og belysningsfladen, således at lys, der transmitteres gennem den enkelte lysventils lyskanal fokuseres passende på belysningsfladen, opnås, at lyset fra hver kanal afsættes i mindre punkter (dots) med høj intensitet på belysningsfladen.

Ved, som angivet i krav 4, at lade de(n) optiske lysleder(e) udgøre af optiske fibre, opnås et lille tab af lysintensitet, samt stor konstruktionsmæssig fleksibilitet i den rumlige placering af de enkelte elementer.

Ved at anvende multimode fibre opnås ligeledes mulighed for at belyse belysningsfladen med mere bredspektret lys.

Ved, som angivet i krav 5, at lade mindst én af lyskilderne udgøre af en kortbuelyslampe (short arc gap lamp), opnås en høj afgiven lyseffekt fra et område med begrænset fysisk udstrækning (høj strålingsintensitet).

Ved, som angivet i krav 6, at lade lyskilden omfatte en kortbuelampe, der inden for en vinkel på +/- 75° i forhold til lampens ækvatorakse (E) på en kugleflade

rundt om lampen har arrangerede lysmodtagende optiske lysledere eller fibre, der er optisk forbundet med og leder lys til lysgiverne, opnås at den overvejende del af det lys, der udsendes fra lyskilden opsamles i lyslederne, hvorved virkningsgraden bliver meget høj.

Ved, som angivet i krav 7, at mindst én af lyskilderne udgøres af en laserkilde, opnås mulighed for at distribuere lyskilderne, således at eksempelvis en række laserkilder kan forsyne det samlede antal lysventiler.

Ved, som angivet i krav 8, at lade belysningsenheden omfatte et antal lysgivere i form af lysledere, der hver er optisk forbundet med en lyskilde arrangeret til belysning af en flerhed af lysventiler arrangeret i en givet fladeform, idet mindst én kollimationslinse er arrangeret mellem lysgiveren og fladeformen, således at kollimeret lys ledes mod flerheden af et første til lysventilerne hørende microlinsearrangement, opnås en homogen belysning af en flerhed af lysventilerne fra hver lysgiver.

Ved, som angivet i krav 9, at lade lysventilernes fladeform udgøre et heksagon, opnås en god tilnærmelse til en cirkel og dermed en høj udnyttelse af lysenergien fra en lysgiver med cirkulær geometri. Derudover er der den fordel at hexagonformede belysningsflader er særdeles fordelagtige at anvende i forbindelse med scannende bevægelser af et antal sammenbyggede belysningsenheder. Hexagoner kan således på passende vis udformes og placeres indbyrdes forskudt i og på tværs af scanneretningen.

Ved, som angivet i krav 10, at lade de enkelte lysventiler være arrangeret i rækker i fladeformens tværretning med lysventilerne i en givet indbyrdes

afstand, idet rækkerne er indbyrdes forsat i tværretningen, opnås mulighed for at fordele lyset lineært over en stor bredde.

Ved, som angivet i krav 11, at arrangere rækkerne således, at alle de enkelte lysventilers projektion på tværretningen i fladeformen resulterer i et antal belysningspunkter med en indbyrdes afstand i tværretningen, opnås at der kan afsættes lys i punkter med en væsentlig højere opløsning end svarende til afstanden mellem de enkelte lysventiler på grund af disses fysiske udstrækning, hvis disse var placeret på en enkelt række i tværretningen.

Ved, som angivet i krav 12, at arrangere, at lysventilernes fladeform eller fladeformer er arrangeret på en eller flere belysningshoveder, idet hvert belysningshoved og belysningsfladen er indrettet til at foretage en relativ bevægelse over et belysningsareal, idet indretningen ligeledes er forsynet med en styreenhed til styring af lysventilerne i afhængighed af den relative bevægelse mellem belysningshovedet og belysningsfladen, opnås en fordelagtig udførelsesform ifølge opfindelsen.

Ved, som angivet i krav 13, at lade belysningshovedet eller hovederne være arrangeret som en stang, hvis relative bevægelse med belysningsfladen er en enkel fremadskridende bevægelse i stangens tværretning, opnås at der kan afsættes belyste punkter i hele, eller en væsentlig del af belysningsfladens bredde, og i kraft af scannebevægelsen på hele eller en væsentlig del af belysningsfladen.

Ved, som angivet i krav 14, at lade belysningsenheden mellem lysventilarrangementet og belysningsfladen

yderligere omfatte optiske midler til spredning af de af lyskanalerne afgivne lysstråler over belysningsfladen, opnås at der kan eksponeres over et område, der er fysisk større end det område lyskanalerne dækker over, hvorved der eksempelvis kan kompenseres for ikke-aktive randområder omkring et lysventilarrangement.

Ved, som angivet i krav 15, at lade belysningsenhedens lysventiler udgøre af elektrooptisk baserede lysventiler (spatial light modulators) såsom LCD, PDLC, PLZT, FELCD eller Kerr-cells, opnås en stor designmæssig fleksibilitet med hensyn til valg af lysmodulatorprincip i den enkelte applikation, herunder blandt andet at at standardiserede komponenter kan reducere fremstillingprisen.

Ved, som angivet i krav 16, at lade belysningsenhedens lysventiler udgøre af refleksionsbaserede elektromekaniske lysventiler såsom DMD-chips, opnås en løsning med høj spatial opløsning.

Ved, som angivet i krav 17, at lade belysningsenhedens lysventiler udgøre af transmissionsbaserede elektromekaniske lysventiler, opnås en løsning med meget lille dæmpning af lys gennem modulatoren.

Ved, som angivet i krav 18, at lade belysningsenhedens lysledere være ordnet således i forhold til lysventilarrangementet, at den tilførte optiske energi til hver delmængde af lysventiler ikke afviger væsentligt indbyrdes, når delmængderne af lysventiler belyser naboarealer eller arealer, der ligger tæt på hinanden på belysningsfladen, opnås at den tilladte variation i lysintensitet mellem samtlige lysgivere kan øges uden at dette bliver synligt.

Ved, som angivet i krav 19, at lade de lysmodtagende ender af lyslederne være samlet i mindst ét bundt, der direkte eller indirekte modtager lys fra en reflektor eller et reflektorsystem, der er optisk forbundet med mindst én lampe, opnås en bedre mulighed for centralt at styre såvel mængde som variation af det lys, der injiceres i lyslederen.

Figurerne

Opfindelsen vil i det følgende blive beskrevet under henvisning til figurer, hvor

fig.1 viser en principskitse af en udførelsesform ifølge opfindelsen,

fig. 2 viser et mere detaljeret skitse af et delareal vist på fig. 1,

fig. 3 viser et yderligere eksempel på udformning af et delareal ifølge opfindelsen,

fig. 4 viser en udførelsesform, hvor de på fig. 3 viste delarealer er arrangerede på eksempelvis en scannestang,

fig. 5 viser en udførelsesform, idet et antal belysningsmoduler er arrangeret på en scannestang,

fig. 6 viser et tværsnit af et belysningssystem ifølge opfindelsen med LCD-lysventiler.

Udførelseseksemplet

På fig. 1 ses en principskitse af en udførelsesform ifølge opfindelsen.

Et belysningssystem omfatter således en lampe 1, der er optisk forbundet med et antal lysmodtagende ender af

lysledere, såsom optiske fibre 3, der er samlet i et fixtur 2.

I den modsatte ende af de optiske fibre 3 er de optiske fibre 3 optisk forbundet med et antal delarealer eller zoner 4, der hver omfatter et antal lysventiler (ikke vist).

Lyslederne 3 leder således lys til delarealerne 4, hvor det tilledte lys moduleres på en belysningsflade 5.

Det på fig. 1 viste lysventilarrangement kan eksempelvis være indrettet til glimteksponering, dvs. at alle belysningspunkter på den samlede belysningsflade kan belyses samtidig.

Det på fig. 1 viste lysventilarrangement kan endvidere være opbygget over netop et array med et meget stort antal lysventiler, idet det samlede areal er opdelt i et antal delarealer, der hvert belyses af en lysleder 3.

På fig. 2 ses et nærbillede af et af de viste delarealer 4 på fig. 1.

Hvert delareal omfatter et antal light valves 6, der individuelt kan styres elektrisk af en dermed forbundet kontrolenhed (ikke vist). Lysventilarrangementet kan eksempelvis udgøres af et LCD display med en given ønsket opløsning.

Hele delarealet af light valves 4 belyses af én lysleder 3, der er arrangeret således at en lysstråle 10, der emitteres fra lyslederen 3 kan tillede optisk energi til alle light valves 6 i delarealet.

Det skal bemærkes, at lysstrålen som oftest vil blive tilledt gennem kollimeringsoptik, således at den til lysventilarrangementet tilledte lysstråle er plan og energiuniform.

På fig. 3 ses et yderligere eksempel på udformning af et delareal ifølge opfindelsen.

I forhold til det viste delareal på fig. 2 bemærkes det indledningsvis, at der er færre lysventiler i hvert delareal.

Det viste delareal 4 omfatter således et antal lysventiler 6 med lysventilåbninger 6'.

Det ses, at det valgte lysventilarrangement har fået blændet lysventilerne i hjørnet af, således at formen af delarealet nærmer sig en omskrevet cirkel. Det er underforstået, at det valgte eksempel af forklaringsmæssige årsager har et reduceret antal lysventiler, hvorfor et større antal lysventiler nemmere kan tilnærmes en ønsket fladeformet eller matrix-struktur.

En fordel ved en tilnærmelsesvist cirkulær fladeform er, at det er forholdsvist nemt at fordele lys over lysventilarrangementet fra en lysleder, idet en lysleder typisk vil have et cirkulært tværsnit.

På fig. 4 ses, hvorledes tre delarealer 14 af lysventiler 6, 6' er arrangeret som samvirkende belysningsenheder til udøvelse af en scannebevægelse og belysning vinkelret på en scannelinie 9. Ved den viste projektion af lys på scannelinien 9 bevæger det samlede lysventilarragement sig vinkelret på scannelinien 9 og foretager en belysning i enhedernes normalretning. Som det fremgår giver de

enkelte lysventilers 6 lysåbning 6' et bidrag på scannelinien med ækvidistante belysningspunkter i form af et belysningspunkt 6''.

Det viste arrangement kan eksempelvis være opbygget på en bevægelig scannestang (ikke vist) med tilhørende styreelektronik (ikke vist).

Den viste opbygning kan udformes mere økonomisk end eksempelvis arrangementer til glimteksponering, ligesom det vil være muligt på en enkel måde at forøge opløsningen. Dette vil fremgå mere detaljeret i det følgende.

Som det fremgår af eksemplet har de anvendte delarealer fået tilført en hældning i forhold til deres projektion på scannelinien 9. Det viste arrangement giver således en forøgelse af opløsningen, der svarer til antallet af rækker i lysventilarrangementet. Vinkelen i forhold til scannelinien 9 af hvert belysningsmodul tilpasses så der bliver ækvidistant afstand mellem punkterne 6'' projiceret ned på linien 9.

Alternativt til det ovenfor beskrevne arrangement, kan systemet indrettes med redundans ved at lade flere lysventiler belyse samme belysningspunkt. Dette kan eksempelvis være en udpræget fordel i forbindelse med lysventiltyper, hvor der optræder en vis funktionsusikkerhed, dvs. ikke-fungerende spejle eller ventiler. En sådan redundans kan eksempelvis opnås ved at dreje en større array af lysventiler, således at udvalgte lysventiler, når disse scannes forbi et belysningsflade eller scannelinie belyser samme punkt.

Det skal i den forbindelse erindres, at der generelt må accepteres en meget lille eller ingen fejlprocent for de

involverede lysventiler hvis disse anvendes som "stand alone", hvorfor redundans vil tillade en vis usikkerhed på de enkelte belysningsmoduler. Dette vil igen reducere stykprisen for de involverede lysventilenheder.

En fordel ved det viste eksempel er, at der kan anvendes standard lysventilkonstruktioner med en sædvanlig matrix-placering af lysventilerne, såsom eksempelvis lysventiler af LCD typen, fremfor at skulle fremstille delarealer med et særligt og specifikt layout af lysventiler.

Det er dog underforstået, at de enkelte delarealer eller det samlede lysventilarrangement, hvis dette måtte ønskes, kan produceres i én samlet formation af lysventiler i et givet specifikt layout.

Det skal i øvrigt bemærkes, at en yderligere fordel ved opfindelsen bliver særligt udpræget ved anvendelse af et scannende lysventilarrangement, idet lysventilarrangementet i sin helhed normalt kræver en meget langstrakt lystiltilledning (svarende til længden af den ønskede scannelinie). En sådan langstrakt lysprofil kan være særdeles vanskelig at opnå uden anvendelse af lysledere, idet den anvendte optik kan blive særdeles kompliceret og pladskrævende.

På fig. 5 ses i udsnit en yderligere udførelsesform ifølge opfindelsen, idet lysventil layoutet i dette tilfælde er fremstillet direkte med en rækkeforskydning mellem de enkelte lysventilrækker.

Det viste lysventilarrangement er indrettet til at scanne over en belysningsflade i scanneretningen SD.

Lysventilarrangementet er indrettet med et antal rækkevist placerede lysventiler 6, eksempelvis LCD

lysventiler. Hver lysventil har en belysningsåbning 6', der er elektrisk aktiver- og deaktiverbar. Når lysventilen 6 er åben vil denne således belyse et under lysventilen arrangeret belysningssted. Dette belysningssted vil i det viste tilfælde være en scannelinie 9.

Som vist på tegningen vil lysventilarrangementet projektioner 30 tilsammen danne en belysningslinie SL, hvorpå belysningspunkterne har en indbyrdes given centerafstand. Projektionerne illustrerer hvorledes de enkelte punkter afsættes når de enkelte lysventiler passerer scannelinien SL i retningen SD.

Det er underforstået, at belysningsarrangementet er styret af ikke viste styremidler, der sikrer, at de enkelte lysventiler åbner med en passende indbyrdes tidsforsinkelse, således at en sædvanlig scannelinie gendannes på scannelinien SL, selvom lysventilrækkerne passage over scannelinien er tidsforskudt.

I det viste tilfælde svarer den opnåede belysningsopløsning til den indbyrdes forskydning mellem hver "nabo"-række. Det er dog underforstået at det viste layout kun repræsenterer et af mange tænkelige lysventil lay-outs indenfor opfindelsens rammer.

En fordel ved den viste udformning er at lysventilarrangementet kan fremstilles direkte og målrettet til den opgave indretningen måtte være beregnet for, hvorved den indbyrdes placering af samvirkende belysningsmoduler gøres nemmere.

På fig. 6 ses et tværsnit af en udførelsesform ifølge opfindelsen.

På fig. 6 ses således et belysningssystem omfattende et bundt af lysledere 20, hvis lysmodtagende ender kan arrangeres til modtagelse af lys fra én eller flere lyskilder (ikke viste).

Lyslederbundet 20, der eksempelvis kan bestå af optiske fibre, danner et antal lysgivere, der er arrangeret til belysning af kollimationsoptik 23, således at hver lysgiver i fiberbundtet kollimeres individuelt til kollimerede lysstråler 28.

De kollimerede lysstråler 28 ledes efterfølgende videre til et LCD modulationsboard 24 bestående af én LCD-array, hvori de enkelte LCD lysventiler er indrettet til modulering af det indfaldende lys i afhængighed af elektrisk styresignaler til udgående makrolysstråler 29 af mikrolysstråler. Hver makrolysstråle 29 består af et antal individuelt modulerede mikrolysstråler. Af hensyn til den opnåelige detaljeringsgrad på figuren fremgår mikrolysstrålerne ikke på fig.6.

LCD- boardet kunne som en alternativ udførelse af opfindelsen udformes som et antal LCD-arrays, der hver belyses af netop én eller af en delmængde af lysgivere fra fiberbundtet 20.

Efterfølgende ledes makrolysstrålerne 29 til et antal af makroobjektivsystemer, der hver eksempelvis kan bestå af sammenhørende makrolinser 25, 26. Makroobjektivsystemerne leder efterfølgende makrolysstrålerne til et belysningssted i form af eksempelvis en trykplade.

Den viste udførelsesform kan afhængigt af udformningen og dimensioneringen af det optiske system og LCD-boardet

foretage stationære glimteksponeringer af stationære belysningsflader.

Alternativt kan den viste udførelsesform indrettes til en relativ bevægelse mellem belysningsflade og belysningssystemet i form af eksempelvis en scanning som vist på fig. 4 og fig. 5.

KRAV

1. Belysningsenhed til punktvis belysning af et medium omfattende en flerhed af lysgivere (3) i form af lysledere, der via et lysventilarrangement er arrangeret til belysning af en belysningsflade, idet lysventilarrangementet omfatter et antal elektrisk styrede lysventiler, k e n d e t e g n e t v e d, at mindst to af lysgiverne (3), hver er arrangeret til belysning af en flerhed af lysventiler (6).

2. Belysningsenhed ifølge krav 1, k e n d e t e g n e t v e d, at den yderligere omfatter et første linsearrangement, idet linsearrangementet omfatter mindst én microlinse arrangeret i forhold til hver lysventil, således at det af lysgiveren eller lysgiverne afgivne lys fokuseres på eller i omegnen af den optiske akse for de enkelte lysventiler.

3. Belysningsenhed ifølge krav 1 eller 2, k e n d e t e g n e t v e d, at det yderligere omfatter et andet micro-linsearrangement arrangeret mellem lysventilerne og belysningsfladen, således at lys, der transmitteres gennem den enkelte lysventils lyskanal, fokuseres passende på belysningsfladen (5).

4. Belysningsenhed ifølge krav 1-3, k e n d e t e g n e t v e d, at de(n) optiske lysleder(e) (3) udgøres af optiske fibre, fortrinsvis multimode fibre.

5. Belysningsenhed ifølge krav 1-4, k e n d e t e g n e t v e d, at mindst én af lyskilderne (1) udgøres af en kortbuelyslampe (short arc gap lamp).

6. Belysningsenhed ifølge krav 1-5 k e n d e t e g n e t v e d, at lyskilden omfatter en kortbuelampe (1), der inden for en vinkel på +/- 75° i forhold til lampens ækvatorakse på en kugleflade rundt om lampen har arrangerede lysmodtagende optiske lysledere eller fibre (3), der er optisk forbundet med og leder lys til lysgiverne.

7. Belysningsenhed ifølge krav 1-6, k e n d e t e g n e t v e d, at mindst én af lyskilderne udgøres af en laserkilde.

8. Belysningsenhed ifølge krav 1-7, k e n d e t e g - n e t v e d, at den omfatter et antal lysgivere (3) i form af lysledere, der hver er optisk forbundet med en lyskilde (1) arrangeret til belysning af en flerhed af lysventiler (6) arrangeret i en givet fladeform, idet mindst én kollimationslinse er arrangeret mellem lysgiveren og fladeformen, således at kollimeret lys ledes mod flerheden af et første til lysventilerne hørende microlinsearrangement.

9. Belysningsenhed ifølge krav 8, k e n d e t e g n e t v e d, at lysventilernes fladeform udgør en eller flere heksagoner.

10. Belysningsenhed ifølge krav 8 eller 9, k e n d e - t e g n e t v e d, at de enkelte lysventiler er arrangeret i rækker i fladeformens tværretning (9) med lysventilerne i en givet indbyrdes afstand, og at rækkerne er indbyrdes forsat i tværretningen.

11. Belysningsenhed ifølge krav 8-10, k e n d e t e g - n e t v e d, at rækkerne er arrangeret således, at alle de enkelte lysventilers projektion på tværretningen (9) i

fladeformen resulterer i et antal belysningspunkter med en indbyrdes afstand i tværretningen (9).

12. Belysningsenhed ifølge krav 1-11, k e n d e t e g - n e t v e d, at lysventilernes fladeform eller fladeformer er arrangeret på et eller flere belysningshoveder, idet hvert belysningshoved og belysningsfladen er indrettet til at foretage en relativ bevægelse over et belysningsareal, idet indretningen ligeledes er forsynet med en styreenhed til styring af lysventilerne i afhængighed af den relative bevægelse mellem belysningshovedet og belysningsfladen.

13. Belysningsenhed ifølge krav 1-12, k e n d e t e g - n e t v e d, at belysningshovedet eller belysningshovederne udgør en stang, hvis relative bevægelse med belysningsfladen er en enkel fremadskridende bevægelse i stangens tværretning.

14. Belysningsenhed ifølge krav 1-13, k e n d e t e g - n e t v e d, at belysningsenheden mellem lysventilarrangementet og belysningsfladen yderligere omfatter optiske midler til spredning af de af lyskanalerne afgivne lysstråler over belysningsfladen.

15. Belysningsenhed ifølge krav 1-14, k e n d e t e g - n e t v e d, at belysningsenhedens lysventiler udgøres af elektrooptisk baserede lysventiler (spatial light modulators) såsom LCD, PDLC, PLZT, FELCD eller Kerr-cells.

16. Belysningsenhed ifølge krav 1-15, k e n d e t e g - n e t v e d, at belysningsenhedens lysventiler udgøres af refleksionsbaserede elektromekaniske lysventiler såsom DMD.

17. Belysningsenhed ifølge krav 1-16, k e n d e t e g n e t v e d, at belysningsenhedens lysventiler udgøres af transmissionsbaserede elektromekaniske lysventiler.

18. Belysningsenhed ifølge krav 1-17, k e n d e t e g n e t v e d, at belysningsenhedens lysledere er ordnet således i forhold til lysventilarrangementet, at den tilførte optiske energi til hver delmængde af lysventiler ikke afviger væsentligt indbyrdes, når delmængderne af lysventiler belyser naboarealer eller arealer, der ligger tæt på hinanden på belysningsfladen.

19. Belysningsenhed ifølge krav 1-5 og krav 7-17, k e n d e t e g n e t v e d, at de lysmodtagende ender af lyslederne er samlet i mindst ét bundt, der direkte eller indirekte modtager lys fra en reflektor eller et reflektorsystem, der er optisk forbundet med mindst én lampe.

20. Fremgangsmåde til punktvis belysning af et medium ved hjælp af en flerhed af lysgivere (3) i form af lysledere, der via et lysventilarrangement er arrangeret til belysning af en belysningsflade, idet lysventilarrangementet omfatter et antal elektrisk styrede lysventiler, k e n d e t e g n e t v e d, at mindst to af lysgiverne (3), hver er arrangeret til belysning af en flerhed af lysventiler (6).

21. Fremgangsmåde ifølge krav 20, k e n d e t e g n e t v e d, at det af lysgiveren eller lysgiverne afgivne lys fokuseres på eller i omegnen af den optiske akse for de enkelte lysventiler via et første linsearrangement, idet linsearrangementet omfatter mindst én microlinse arrangeret i forhold til hver lysventil.

22. Fremgangsmåde ifølge krav 20 eller 21, k e n d e t e g n e t v e d, at lyset, der transmitteres gennem den enkelte lysventils lyskanal, fokuseres passende på belysningsfladen (5) via et andet micro-linsearrangement arrangeret mellem lysventilerne og belysningsfladen.

SAMMENDRAG

Opfindelsen angår en belysningsenhed til punktvis belysning af et medium omfattende en flerhed af lysgivere i form af lysledere, der via et lysventilarrangement er arrangeret til belysning af mindst én belysningsflade, idet lysventilarrangementet omfatter et antal elektrisk styrede lysventiler, idet mindst én af lysgiverne (1) er arrangeret til belysning af en flerhed af lysventiler.

(Fig. 1)

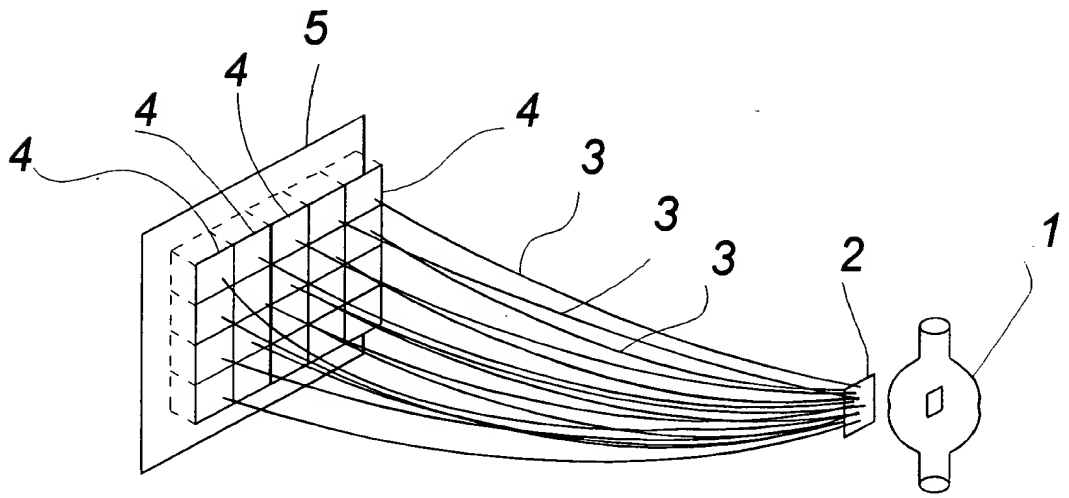

Fig.1

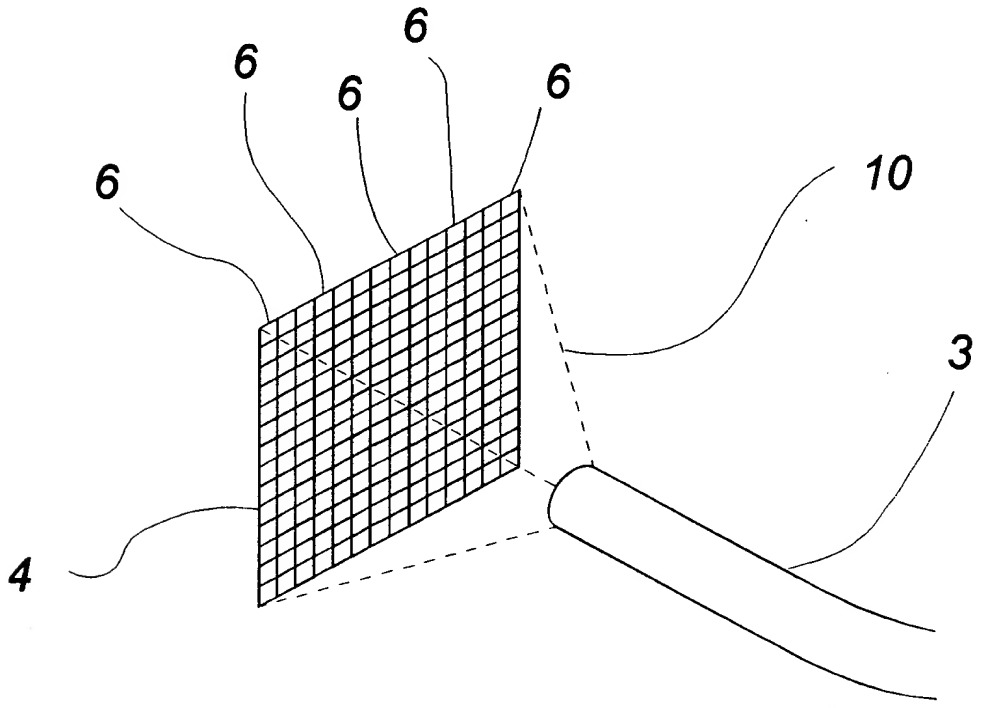

Fig.2

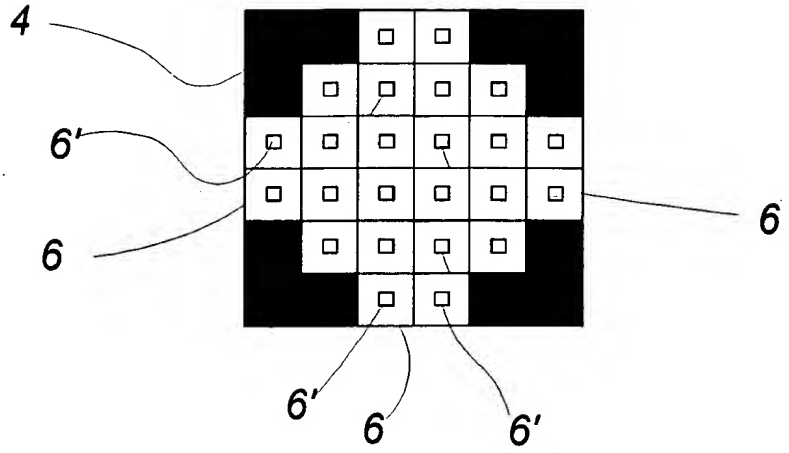

Fig.3

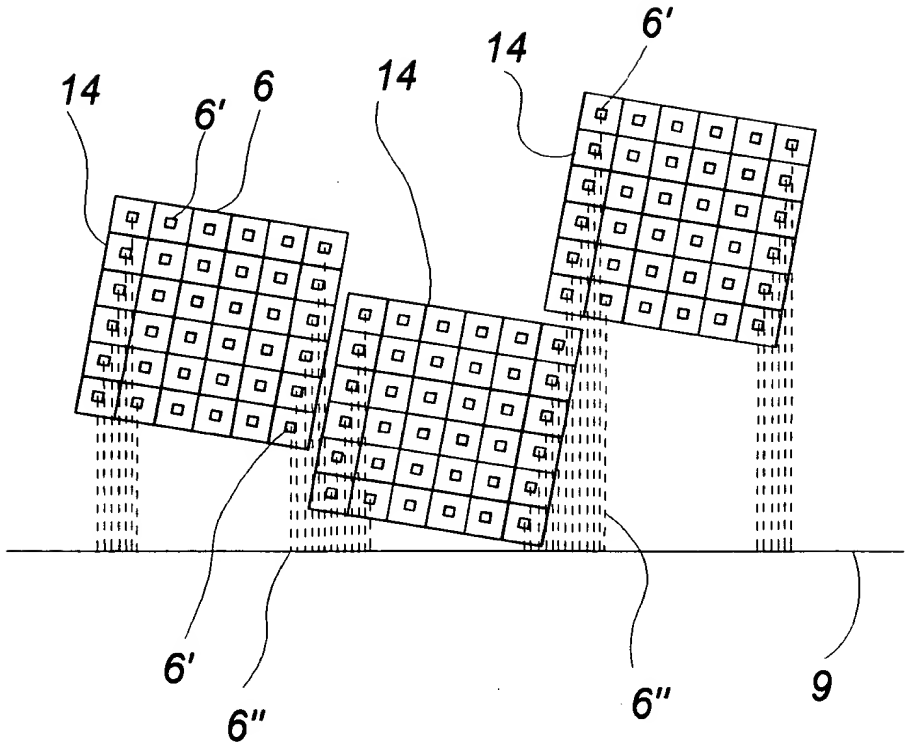

Fig.4

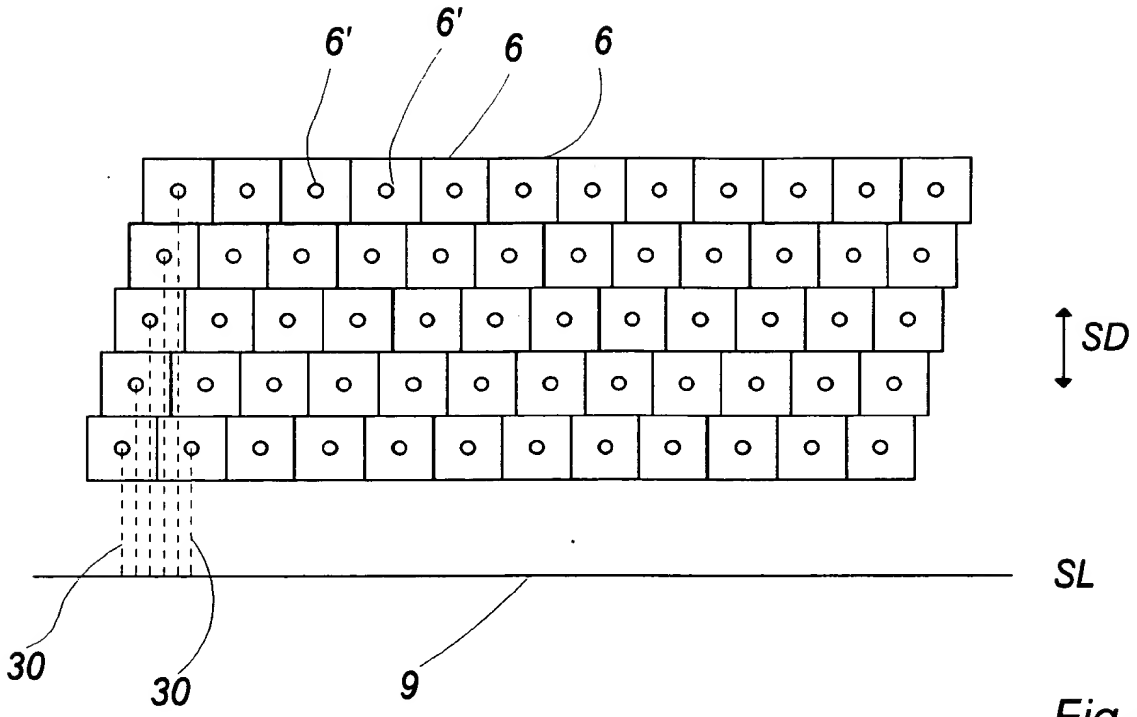

Fig.5

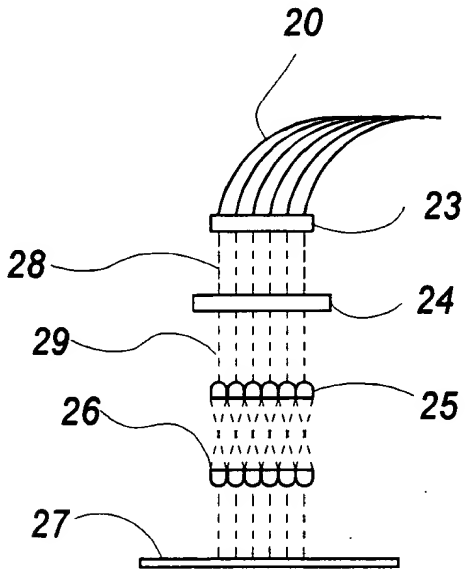

Fig.6

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(71) Applicant *(for all designated States except US)*: DICON A/S [DK/DK]; Sønderskovvej 5, DK–8520 Lystrup (DK).

(72) Inventor; and

(75) Inventor/Applicant *(for US only)*: HENNINGSEN, Henning [DK/DK]; Nørregade 25, DK–8670 Låsby (DK).

(74) Agent: HOFMAN–BANG & BOUTARD, LEHMANN & REE A/S; Ryesgade 3, P.O. Boks 367, DK–8100 Århus C (DK).

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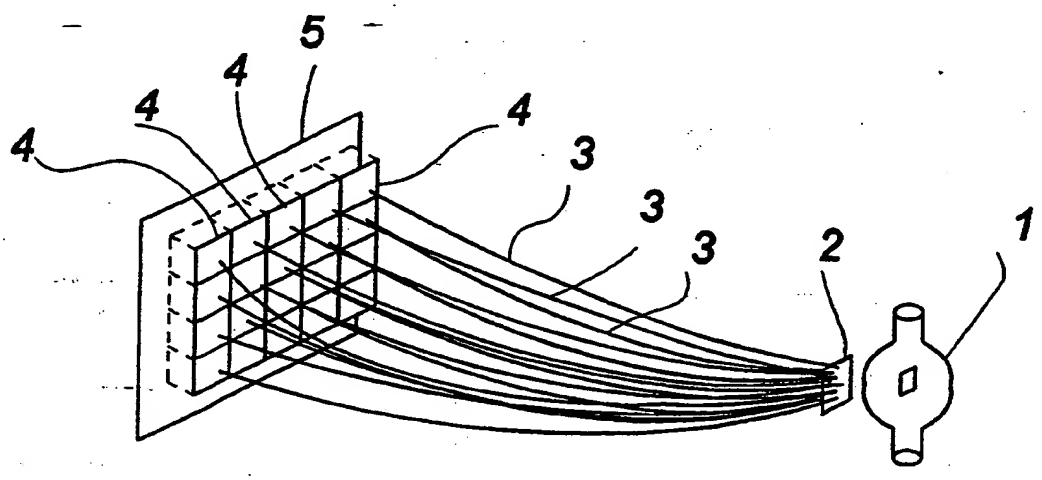

(57) Abstract

The invention relates to an illumination unit for point illumination of a medium comprising a plurality of light emitters in the form of light guides, which are arranged to illuminate at least one illumination face via a light valve arrangement, said light valve arrangement comprising a plurality of electrically controlled light valves, at least one of the light emitters (1) being arranged to illuminate a plurality of light valves.

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AN APPARATUS AND A METHOD OF ILLUMINATING A LIGHT-SENSITIVE MEDIUM

Field of the invention

The invention relates to an illumination unit and a method of point illumination of a medium comprising a plurality of light emitters in the form of light guides which are arranged to illuminate at least one illumination face via a light valve arrangement, said light valve arrangement comprising a plurality of electrically controlled light valves.

The art comprises various types of illumination systems of the type where a continuous high power light source, e.g. an Hg or Xe lamp, illuminates a plurality of illumination points on a light-sensitive medium via a given type of light modulators.

However, the technology has not been a great commercial success, because many light valve types have a very low coefficient of utilization, and, accordingly, distribution of light over a large illumination face will typically give greater optical losses and thereby cause the emitted optical power on the illumination point to be reduced considerably. As a result of this circumstance, the available optical energy will frequently tend to be concentrated in one specific small illumination area, rather than trying to distribute it over a large area for an extended period of time because of the limited illumination power and thereby achieve a reduced illumination power over the individual illumination points.

A drawback of this prior art caused by the above-mentioned problems is that it is necessary to place a very large number of light valves in a light valve array on a

very small area, as it is very difficult to distribute sufficient optical power over a large area, and also difficult to achieve a uniform surface illumination.

Computer to plate technology, which is known e.g. from US Patent No. 5 049 901 in which e.g. printing plates are illuminated via DMD light valves, involves the problem that it is not possible to have sufficient optical power distributed over a large area. The patent thus describes how illumination on a scanning line is maintained as best as possible for the longest possible period of time by illuminating the same scanning line with several rows of light valves. Another consequence of the relatively low illumination power may also be that special printing plates having an increased light sensitivity have to be used, which for one thing are expensive in use and for another make greater requirements with respect to storage and use than the conventional printing plates. A further possible consequence of this relatively low achievable optical energy is that the illumination time of the system must be increased considerably. This increase in time consumption, however, is not very expedient as the overall necessary exposure time for a printing plate is increased considerably.

A further drawback of optical distribution over a large area is that the use of e.g. a large number of light sources may give rise to rather pronounced edge problems which occur at the boundary areas between the illumination profiles and the illumination area of the individual light sources. These edge problems have previously been avoided either by illuminating an illumination area with the same light emitter, or alternatively by illuminating each individual illumination point with a separate optical fibre. Systems of the first-mentioned type, which are known from US Patent Specification No. 4 675 702, have

the drawback that the illumination area is restricted physically, thereby calling for a complicated relative mechanical movement between the illumination unit and the substrate.

The last-mentioned type provides a uniform illumination on the illumination face, as the illumination intensity varies between each illumination point so that the variation of the illumination intensity is not visible. A drawback of the last-mentioned type, which is known from US Patent Specification No. 4 899 222, is that the system is extremely complicated, as an optical fibre is required for each illumination point. This means that the light distribution from the light source to the light modulators requires the use of a very large number of optical fibres, and that a very precise adjustment of each individual optical fibre is required with respect to the light source as well as the light modulators. It should be recalled in this connection that each individual optical fibre must be re-adjusted by routine exchange of light source.

The above-mentioned light modulator systems are additionally vitiated by the drawback that the transmission attenuation is very high, whereby high power illumination on the medium to be illuminated is extremely difficult or downright impossible.

Summary of the invention

When, as stated in claim 1, at least two of the light emitters are arranged to illuminate a plurality of light valves each, it is possible to achieve a very high transmitted illumination intensity combined with a very even and uniform surface illumination.

The prior art does not involve a decided, effective specific distribution from more than one light emitter over a large area or subarea of light valves. When light is distributed via several light emitters, each of which illuminates a plurality of light valves, it is also possible to use several light sources in a simple manner, and each said light source may be dedicated to precisely one light guide so that the power achieved has a maximum value.

A further advantage of distributing light by means of light guides is that light may suitably be mixed in couplers or the like to achieve a greater sum of transmitted power in the individual light guides.

A further advantage of the invention is that it gradually becomes possible to achieve increased input powers from e.g. lamps in the UV range, so that the power transmitted to the light valves will be so great that the individual light emitters can emit light having a sufficiently great energy to illuminate several light valves at the same time.

It has also been found in connection with the use of e.g. UV lamps that the introduction of macro illumination areas, i.e. each area illuminated by a single light guide, gives no significant edge effects between each illumination area, just as it has been found that any great variations between the emitted powers from each light guide (as a function of a varying intensity profile from a connected lamp e.g. because of different positioning of the coupling optics for the individual fibres with respect to the lamp) may be compensated by suitable mixing of the light guides, whereby the result of the complete illumination has a uniform visual appearance without significant differences in intensity in the edge areas.

The above-mentioned mixing may e.g. be performed in consideration of the circumstance that adjacent macro illumination areas receive optical power which does not differ significantly from each other, while macro illumination areas oriented relatively remotely from each other may have a somewhat greater difference in intensity, without this causing considerable visual disturbances on the illumination surface.

An additional advantage of the invention may be obtained by filtering the light to or emitted from the individual light guides, so that the illumination intensity is uniform from all the light guides or some of these.

In contrast to the prior art, an apparatus according to the invention may be constructed in a relatively simple manner, while achieving high resolution, high illumination rate, good precision and uniform illumination intensity over a very large illumination area.

The invention is particularly advantageous in connection with light valves which are vitiated by relatively great losses. An example of such light valve types may e.g. be electrooptically based light valves, such as LCD, PDLC, PLZT, FELCD and Kerr cells. Other types of light valves may e.g. be electromechanical reflection-based light modulators of the DMD type.

According to the invention, it is thus possible to sum light over a large surface in a simple manner using relatively few light guides, just as it is possible to orient the light emitters in the illumination system relatively freely as the light emitters consist of light guide ends rather than e.g. a light source with associated optical system, drivers and coolants.

A particularly advantageous embodiment of the invention is achieved for transmissive light valves, as these result in the fewest possible optical losses, which may be quite decisive for the functionality of certain applications.

When, as stated in claim 2, the illumination unit additionally comprises a first lens arrangement, said lens arrangement comprising at least one micro lens arranged with respect to each light valve so that the light emitted by the light emitter or emitters is focused on or in the vicinity of the optical axis of the individual light valves, a high utilization of the light power emitted from the light emitter is achieved.

When, as stated in claim 3, the illumination arrangement additionally comprises a second micro lens arrangement arranged between the light valves and the illumination face, so that light transmitted through the light channel of the individual light valve is focused suitably on the illumination surface, it is ensured that the light from each channel falls on small points with high intensity on the illumination surface.

When, as stated in claim 4, the optical light guide or guides are formed by optical fibres, a small loss of light intensity as well as great constructional flexibility in the spatial positioning of the individual elements is achieved.

The use of multimode fibres opens up the possibility of illuminating the illumination surface with more broad-spectral light.

When, as stated in claim 5, at least one of the light sources is formed by a short arc gap lamp, a high emitted light power is achieved from an area of limited physical extent (high radiation intensity).

When, as stated in claim 6, the light source comprises a short arc gap lamp having light receiving optical light guides or fibres which are arranged within an angle of +/- 75° with respect to the equator axis (E) of the lamp on a ball face around the lamp, and which are optically connected to and conduct light to the light emitters, it is ensured that the predominant part of the light emitted from the light source is gathered in the light guides, whereby the coefficient of utilization is very high.

When, as stated in claim 7, at least one of the light sources is formed by a laser source, it is possible to distribute the light sources so that e.g. a row of laser sources can supply the total number of light valves.

When, as stated in claim 8, the illumination unit comprises a plurality of light emitters in the form of light guides, each of which is optically connected to a light source arranged to illuminate a plurality of light valves arranged in a given face shape, at least one collimation lens being arranged between the light emitter and the face shape so that collimated light is conducted to a first micro lens arrangement associated with the plurality of light valves, a homogeneous illumination of a plurality of the light valves from each light emitter is achieved.

When, as stated in claim 9, the face shape of the light valves forms a hexagon, a good approximation to a circle and thereby a high utilization of the light energy from a light emitter of circular geometry are achieved. Another

advantage is that hexagonal illumination faces are extremely advantageous to use in connection with scanning movements of a plurality of illumination units built together. Thus, hexagons may suitably be shaped and positioned mutually offset in and transversely to the scanning direction.

When, as stated in claim 10, the individual light valves are arranged in rows in the transverse direction of the face shape with the light valves at a given mutual distance, said rows being mutually offset in the transverse direction, it is possible to distribute the light linearly over a great width.

When, as stated in claim 11, the rows are arranged such that the projection of all the individual light valves in the transverse direction in the face shape results in a plurality of illumination points at a mutual distance in the transverse direction, it is ensured that light may fall on points with a considerably higher resolution than corresponding to the distance between the individual light valves because of their physical extent if these were positioned in a single row in the transverse direction.

When, as stated in claim 12, the face shape or shapes of the light valves are arranged on one or more illumination heads, each illumination head and the illumination face being adapted to perform a relative movement across an illumination area, said device being also provided with a control unit for controlling the light valves in dependence on the relative movement between the illumination head and the illumination face, an advantageous embodiment of the invention is achieved.

When, as stated in claim 13, the illumination head or heads are arranged as a rod whose relative movement with the illumination face is a simple progressing movement in the transverse direction of the rod, it is ensured that illuminated points may be generated in the entire or a considerable part of the width of the illumination face and by virtue of the scanning movement on the entire or a considerable part of the illumination face.

When, as stated in claim 14, the illumination unit between the light valve arrangement and the illumination face additionally comprises optical means for spreading the light beams emitted by the light channels across the illustration face, exposure is ensured over an area which is physically larger than the area covered by the light channels, thereby e.g. allowing compensation for non-active edge areas around a light valve arrangement.

When, as stated in claim 15, the light valves of the illumination unit are formed by electrooptically based light valves (spatial light modulators), such as LCD, PDLC, PLZT, FELCD or Kerr cells, a great design flexibility is achieved with respect to selection of light modulator principle in the individual application, including also that standardized components can reduce the production price.

When, as stated in claim 16, the light valves of the illumination unit are formed by reflection based electromechanical light valves, such as DMD chips, a solution with high spatial resolution is achieved.

When, as stated in claim 17, the light valves of the illumination unit are formed by transmission based electromechanical light valves, a solution with a very low dimming of light through the modulator is achieved.

When, as stated in claim 18, the light guides of the illumination device are so arranged with respect to the light valve arrangement that the optical energy fed to each subset of light valves does not differ significantly from each other when the subsets of light valves illuminate adjacent areas or areas close to each other on the illumination face, it is ensured that the permissible variation in light intensity between all light emitters may be increased without this becoming visible.

When, as stated in claim 19, the light receiving ends of the light guides are gathered in at least one bundle which directly or indirectly receives light from a reflector or a reflector system optically connected to at least one lamp, a better possibility of centrally controlling both amount and variation of the light injected into the light guide is achieved.

Drawings

The invention will be explained more fully below with reference to the drawings, in which

fig. 1 shows a basic sketch of an embodiment of the invention,

fig. 2 shows a more detailed sketch of a subarea shown in fig. 1,

fig. 3 shows an additional example of an embodiment of a subarea according to the invention,

fig. 4 shows an embodiment in which the subareas shown in fig. 3 are arranged on e.g. a scanning rod,

fig. 5 shows an embodiment with a plurality of illumination modules arranged on a scanning rod,

fig. 6 shows a cross-section of an illumination system according to the invention with LCD light valves.

Example

Fig. 1 shows a basic sketch of an embodiment of the invention.

Thus, an illumination system comprises a lamp 1 which is optically connected with a plurality of light receiving ends of light guides, such as optical fibres 3 which are gathered in a fixture 2.

At the opposite end of the optical fibres 3, the optical fibres 3 are optically connected to a plurality of subareas or zones 4, each of which comprises a plurality of light valves (not shown).

The light guides 3 thus conduct light to the subareas 4 where the fed light is modulated on an illumination face 5.

The light valve arrangement shown in fig. 1 may e.g. be arranged for flash exposure, i.e. all illumination points on the complete illumination face may be illuminated at the same time.

The light valve arrangement shown in fig. 1 may moreover be constructed on the basis of an array having a very large number of light valves, the total area being divided into a plurality of subareas which each are illuminated by a light guide 3.

Fig. 2 is a close-up of one of the subareas 4 shown in fig. 1.

Each subarea comprises a plurality of light valves 6 which may individually be controlled electrically by a control unit (not shown) connected to it. The light valve arrangement may e.g. be formed by an LCD display with a given desired resolution.

The entire subarea of light valves 4 is illuminated by one light guide 3 so arranged that a light beam 10, emitted from the light guide 3, can supply optical energy to all the light valves 6 in the subarea.

It should be noted that the light beam will frequently be supplied through collimation optics so that the light beam supplied to the light valve arrangement is plane and uniform in terms of energy.

Fig. 3 shows a further example of an embodiment of a subarea according to the invention.

With respect to the subarea shown in fig. 2, it is noted initially that there are fewer light valves in each subarea.

The shown subarea 4 thus comprises a plurality of light valves 6 with light valve apertures 6'.

It will be seen that the selected light valve arrangement has had the light valves at the corner diaphragmed so that the shape of the subarea approximates a circumcircle. It will be appreciated that, for explanatory reasons, the selected example has a reduced number of light valves, and a larger number of light valves can therefore

be approximated more easily to a desired face-shaped or matrix structure.

An advantage of an approximately circular face shape is that it is relatively easy to distribute light over the light valve arrangement from a light guide, as a light guide will typically have a circular cross-section.

It will be seen from fig. 4 how three subareas 14 of light valves 6, 6' are arranged as cooperating illumination units for performing a scanning movement and illumination perpendicularly to a scanning line 9. In the shown projection of light on the scanning line 9 the complete light valve arrangement moves perpendicularly to the scanning line 9 and performs illumination in the normal direction of the units. As will appear, the light aperture 6' of the individual light valves 6 gives a contribution on the scanning line with equidistant illumination points in the form of an illumination point 6".

The shown arrangement may e.g. be constructed on a movable scanning rod (not shown) with associated control electronics (not shown).

The shown structure may be built more economically than e.g. arrangements for flash exposure, just as it will be possible to increase the resolution in a simple manner. This will be discussed in greater detail below.

As will appear from the example, the subareas used have an inclination with respect to their projection on the scanning line 9. The shown arrangement thus gives an increase in the resolution which corresponds to the number of rows in the light valve arrangement. The angle with respect to the scanning line 9 of each illumination mod-

ule is adapted so as to create an equidistant spacing between the points 6" projected down on the line 9.

As an alternative to the arrangement described above, the system may be arranged with redundancy by allowing several light valves to illuminate the same illumination point. This may e.g. be a distinct advantage in connection with light valve types in which a certain functional uncertainty occurs, i.e. non-functioning mirrors or valves. Such a redundancy may e.g. be achieved by rotating a larger array of light valves so that selected light valves, when scanning past an illumination face or scanning line, illuminate the same point.

It should be recalled in this connection that generally a very small or no percentage of error must be accepted for the light valves involved if these are used as "stand alone", for which reason redundancy will allow some uncertainty on the individual illumination modules. This in turn reduces the unit price of the light valve units involved.

An advantage of the shown example is that standard light valve structures may be used with an ordinary matrix position of the light valves, such as e.g. light valves of the LCD type, rather than having to produce subareas with a particular and specific layout of light valves.

However, it will be appreciated that the individual subareas or the complete light valve arrangement, if so desired, may be produced in one total formation of light valves in a given specific layout.

It should moreover be noted that a further advantage of the invention is particularly pronounced when using a scanning light valve arrangement, as the light valve ar-

rangement in its entirety normally requires a very elongated light supply line (corresponding to the length of the desired scanning line). Such an elongated light profile may be extremely difficult to achieve without using light guides, as the optics used may be extremely complicated and bulky.

Fig. 5 shows a section of a further embodiment of the invention, the light valve layout being produced directly in this case with row displacement between the individual light valve rows.

The light valve arrangement shown is adapted to scan across an illumination face in the scanning direction SD.

The light valve arrangement is arranged with a plurality of light valves 6 positioned in rows, e.g. LCD light valves. Each light valve has an illumination aperture 6' which is electrically activatable and deactivatable. When the light valve 6 is open, it will thus illuminate an illumination place arranged below the light valve. This illumination place will be a scanning line 9 in the shown case.

As shown in the drawing, the light valve arrangement projections 30 together form an illumination line SL on which the illumination points have a mutual given centre distance. The projections illustrate how the individual points are generated when the individual light valves pass the scanning line SL in the direction SD.

It will be appreciated that the illumination arrangement is controlled by control means (not shown) which ensure that the individual light valves open with a suitable mutual time delay so that an ordinary scanning line is reformed on the scanning line SL, even though the passage

of the light valve rows across the scanning line is temporally staggered.

In the shown case the illumination resolution achieved corresponds to the mutual shifting between each adjacent row. However, it will be appreciated that the layout shown just represents one of many conceivable light valve layouts within the scope of the invention.

An advantage of the shown embodiment is that the light valve arrangement may be produced directly and specifically for the task for which the device might be intended, thereby facilitating the mutual positioning of cooperating illumination modules.

Fig. 6 shows a cross-section of an embodiment according to the invention.

Fig. 6 thus shows an illumination system comprising a bundle of light guides 20 whose light receiving ends may be arranged to receive light from one or more light sources (not shown).

The light guide bundle 20, which may e.g. consist of optical fibres, forms a plurality of light emitters arranged to illuminate collimation optics 23 so that each light emitter in the fibre bundle is collimated individually to collimated light beams 28.

The collimated light beams 28 are subsequently conducted to an LCD modulation board 24 consisting of one LCD array, in which the individual LCD light valves are adapted to modulate the incident light in dependence on electrical control signals to outgoing macro light beams 29 of micro light beams. Each macro light beam 29 consists of a plurality of individually modulated micro light beams.

The micro light beams are not shown in fig. 6 owing to the resolution achievable in the figure.

As an alternative embodiment of the invention the LCD board might be constructed as a plurality of LCD arrays which each are illuminated by precisely one light emitter or a subset of light emitters from the fibre bundle 20.

Subsequently, the macro light beams 29 are conducted to a plurality of macro objective systems which each may consist of e.g. associated macro lenses 25, 26. The macro objective systems subsequently conduct the macro light beams to an illumination point in the form of e.g. a printing plate.

The shown embodiment can perform stationary flash exposures of stationary illumination faces depending on the structure and dimensioning of the optical system and the LCD board.

Alternatively, the shown embodiment may be arranged for relative movement between the illumination face and the illumination system in the form of e.g. a scanning, as shown in fig. 4 and fig. 5.

PATENT CLAIMS

1. An illumination unit for point illumination of a medium comprising a plurality of light emitters (3) in the form of light guides arranged to illuminate an illumination face via a light valve arrangement, said light valve arrangement comprising a plurality of electrically controlled light valves, c h a r a c t e r i z e d in that at least two of the light emitters (3) are arranged to illuminate a plurality of light valves (6) each.

2. An illumination unit according to claim 1, c h a r a c t e r i z e d in that it additionally comprises a first lens arrangement, said lens arrangement comprising at least one micro lens arranged with respect to each light valve so that the light emitted by the light emitter or emitters is focused on or in the vicinity of the optical axis of the individual light valves.

3. An illumination unit according to claim 1 or 2, c h a r a c t e r i z e d in that it additionally comprises a second micro lens arrangement arranged between the light valves and the illumination face, so that light transmitted through the light channel of the individual light valve is suitably focused on the illumination face (5).

4. An illumination unit according to claims 1-3, c h a r a c t e r i z e d in that the optical light guide or guides (3) are formed by optical fibres, preferably multimode fibres.

5. An illumination unit according to claims 1-4, c h a r a c t e r i z e d in that at least one of the light sources (1) is formed by a short arc gap lamp.

6. An illumination unit according to claims 1-5, c h a r a c t e r i z e d in that the light source comprises a short arc gap lamp (1) having light receiving optical light guides or fibres (3) which are arranged within an angle of +/- 75° with respect to the equator axis of the lamp on a ball face around the lamp, and which are optically connected to and conduct light to the light emitters.

7. An illumination unit according to claims 1-6, c h a r a c t e r i z e d in that at least one of the light sources is formed by a laser source.

8. An illumination unit according to claims 1-7, c h a r a c t e r i z e d in that it comprises a plurality of light emitters (3) in the form of light guides, each of which is optically connected to a light source (1) arranged to illuminate a plurality of light valves (6) arranged in a given face shape, at least one collimation lens being arranged between the light emitter and the face shape so that collimated light is conducted to a first micro lens arrangement associated with the plurality of light valves.

9. An illumination unit according to claim 8, c h a r a c t e r i z e d in that the face shape of the light valves forms one or more hexagons.

10. An illumination unit according to claim 8 or 9, c h a r a c t e r i z e d in that the individual light valves are arranged in rows in the transverse direction (9) of the face shape with the light valves at a given mutual distance, and that the rows are mutually offset in the transverse direction.

11. An illumination unit according to claims 8-10,

c h a r a c t e r i z e d in that the rows are arranged such that the projection of all the individual light valves in the transverse direction (9) in the face shape results in a plurality of illumination points at a mutual distance in the transverse direction (9).

12. An illumination unit according to claims 1-11, c h a r a c t e r i z e d in that the face shape or shapes of the light valves are arranged on one or more illumination heads, each illumination head and the illumination face being adapted to perform a relative movement across an illumination area, said device being also provided with a control unit for controlling the light valves in dependence on the relative movement between the illumination head and the illumination face.

13. An illumination unit according to claims 1-12, c h a r a c t e r i z e d in that the illumination head or heads constitute a rod whose relative movement with the illumination face is a single progressing movement in the transverse direction of the rod.

14. An illumination unit according to claims 1-13, c h a r a c t e r i z e d in that the illumination unit between the light valve arrangement and the illumination face additionally comprises optical means for spreading the light beams emitted by the light channels across the illumination face.

15. An illumination unit according to claims 1-14, c h a r a c t e r i z e d in that the light valves of the illumination unit are formed by electrooptically based light valves (spatial light modulators), such as LCD, PDLC, PLZT, FELCD or Kerr cells.

16. An illumination unit according to claims 1-15,

c h a r a c t e r i z e d in that the light valves of the illumination unit are formed by reflection based electromechanical light valves, such as DMD.

17. An illumination unit according to claims 1-16, c h a r a c t e r i z e d in that the light valves of the illumination unit are formed by transmission based electromechanical light valves.

18. An illumination unit according to claims 1-17, c h a r a c t e r i z e d in that the light guides of the illumination unit are so arranged with respect to the light valve arrangement that the optical energy fed to each subset of light valves does not differ significantly from each other when the subsets of light valves illuminate adjacent areas or areas close to each other on the illumination face.

19. An illumination unit according to claims 1-5 and claims 7-17, c h a r a c t e r i z e d in that the light receiving ends of the light guides are gathered in at least one bundle which directly or indirectly receives light from a reflector or a reflector system optically connected to at least one lamp.

20. A method of point illumination of a medium by means of a plurality of light emitters (3) in the form of light guides which are arranged to illuminate an illumination face via a light valve arrangement, said light valve arrangement comprising a plurality of electrically controlled light valves, c h a r a c t e r i z e d in that at least two of the light emitters (3) are arranged to illuminate a plurality of light valves (6) each.

21. A method according to claim 20, c h a r a c t e r -

i z e d in that the light emitted by the light emitter or emitters is focused on or in the vicinity of the optical axis of the individual light valves via a first lens arrangement, said lens arrangement comprising at least one micro lens arranged with respect to each light valve.

22. A method according to claim 20 or 21, c h a r a c t e r i z e d in that the light transmitted through the light channel of the individual light valve is suitably focused on the illumination face (5) via a second micro lens arrangement arranged between the light valves and the illumination face.

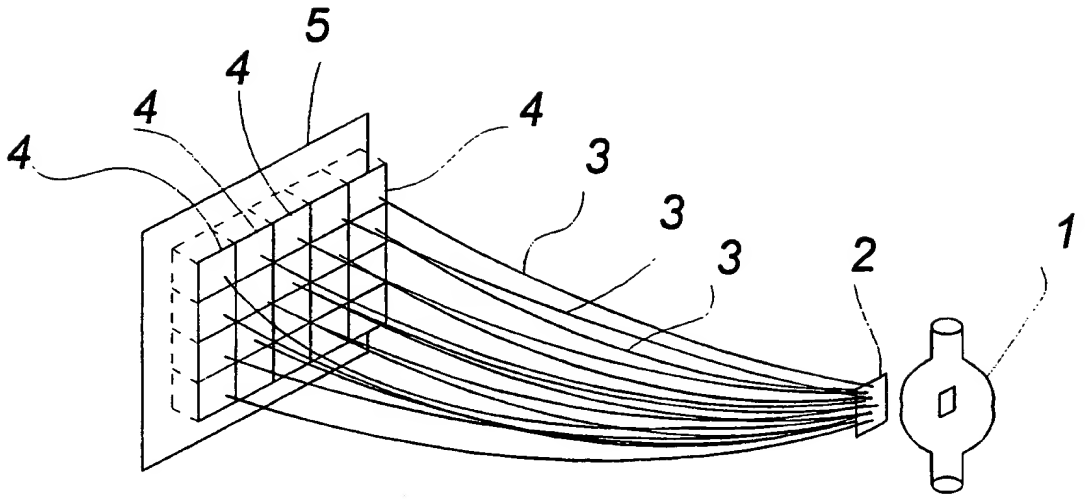

Fig.1

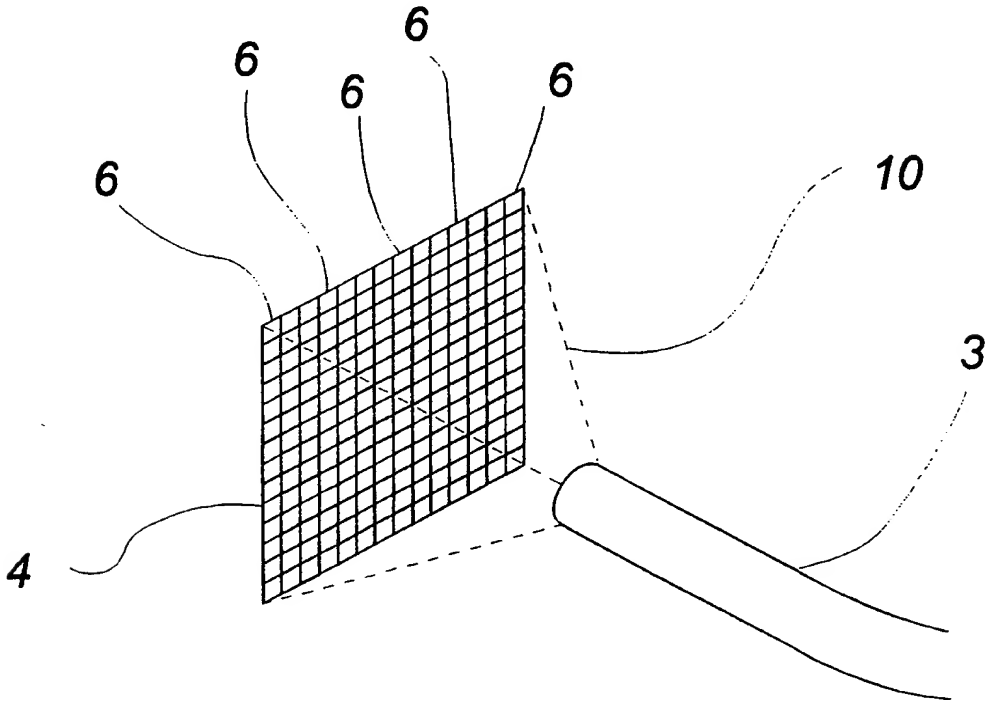

Fig.2

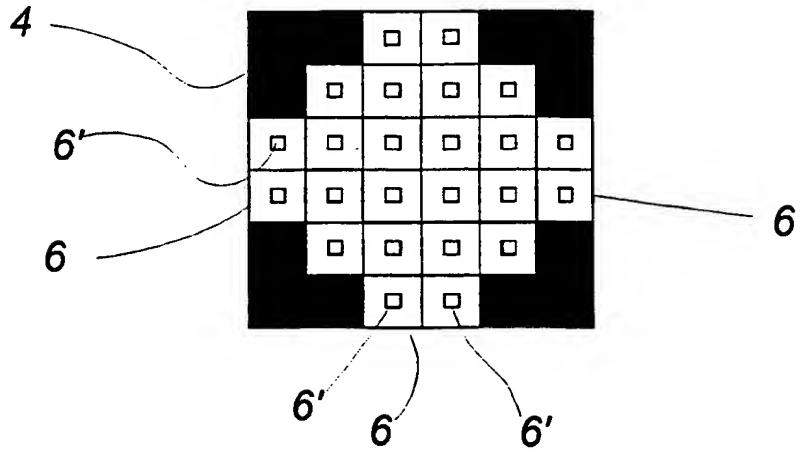

Fig.3

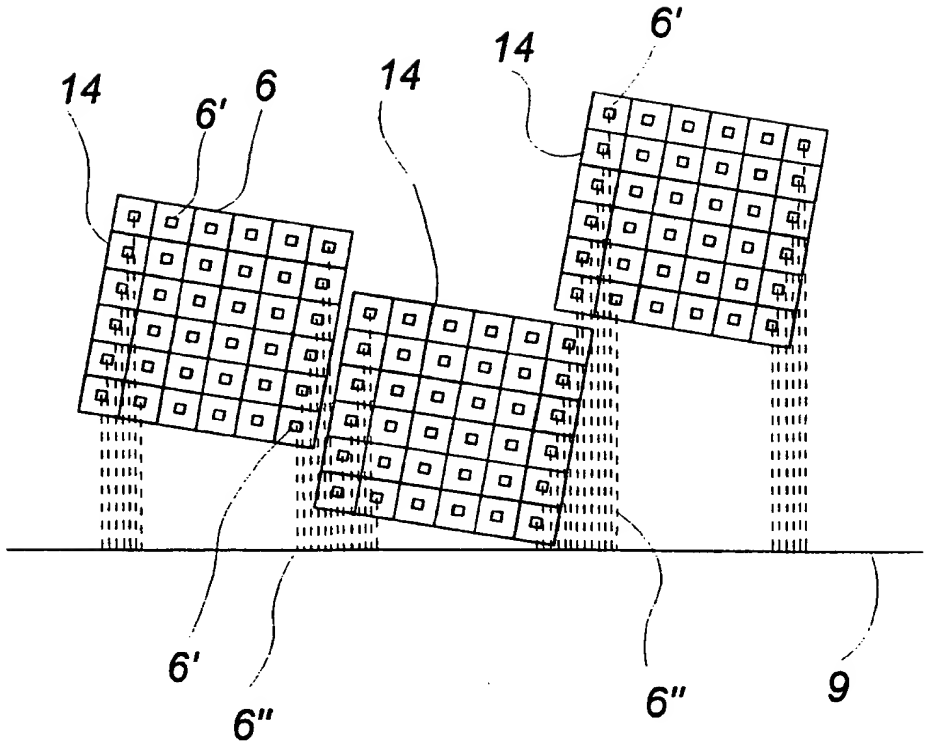

Fig.4

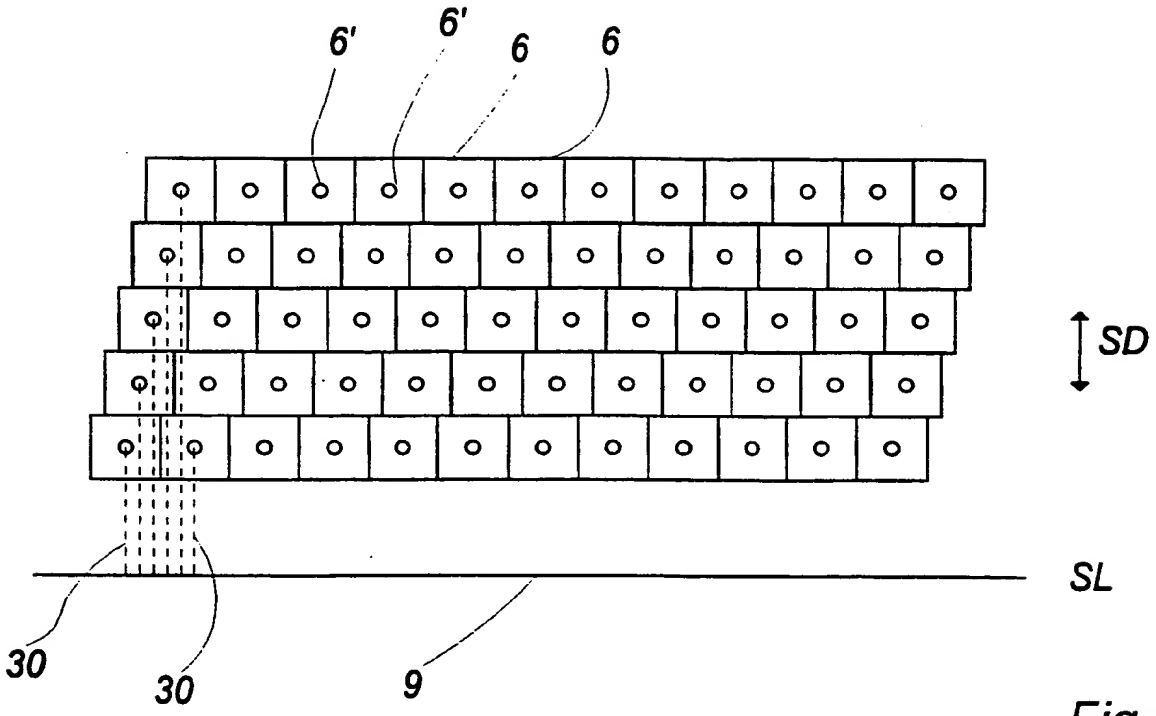

Fig.5

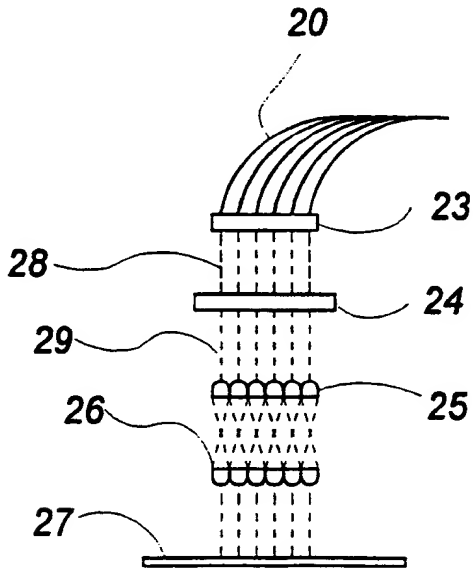

Fig.6

INTERNATIONAL SEARCH REPORT

International application No.
PCT/DK 98/00154

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: G02F 1/1335, H04N 9/31
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: G02F, H04N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPI

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5444235 A (G.R. REDFORD), 22 August 1995 (22.08.95), column 3, line 35 - column 4, line 27, figure 1, abstract --	1,4-20
X	US 4859034 A (Y. SHIRAISHI ET AL.), 22 August 1989 (22.08.89), column 4, line 46 - line 56; column 16, line 64 - column 17, line 34, figures 8,13, abstract --	1,4-20
X	US 5394254 A (L.T. CHENG), 28 February 1995 (28.02.95), column 5, line 51 - column 6, line 45, figure 6, abstract --	1,4-20

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

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"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
21 August 1998	26 -08- 1998
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Karin Säfsten Telephone No. +46 8 782 25 00

INTERNATIONAL SEARCH REPORT

International application No.
PCT/DK 98/00154

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5583669 A (Y. FUSHIMI ET AL.), 10 December 1996 (10.12.96), figure 15, abstract -- --------	2,3,21,22

INTERNATIONAL SEARCH REPORT

Information on patent family members

27/07/98

International application No.
PCT/DK 98/00154

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		JP 58114978 A	08/07/83
		US 4589732 A	20/05/86
US 5394254 A	28/02/95	NONE	
US 5583669 A	10/12/96	JP 6034963 A	10/02/94
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